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by

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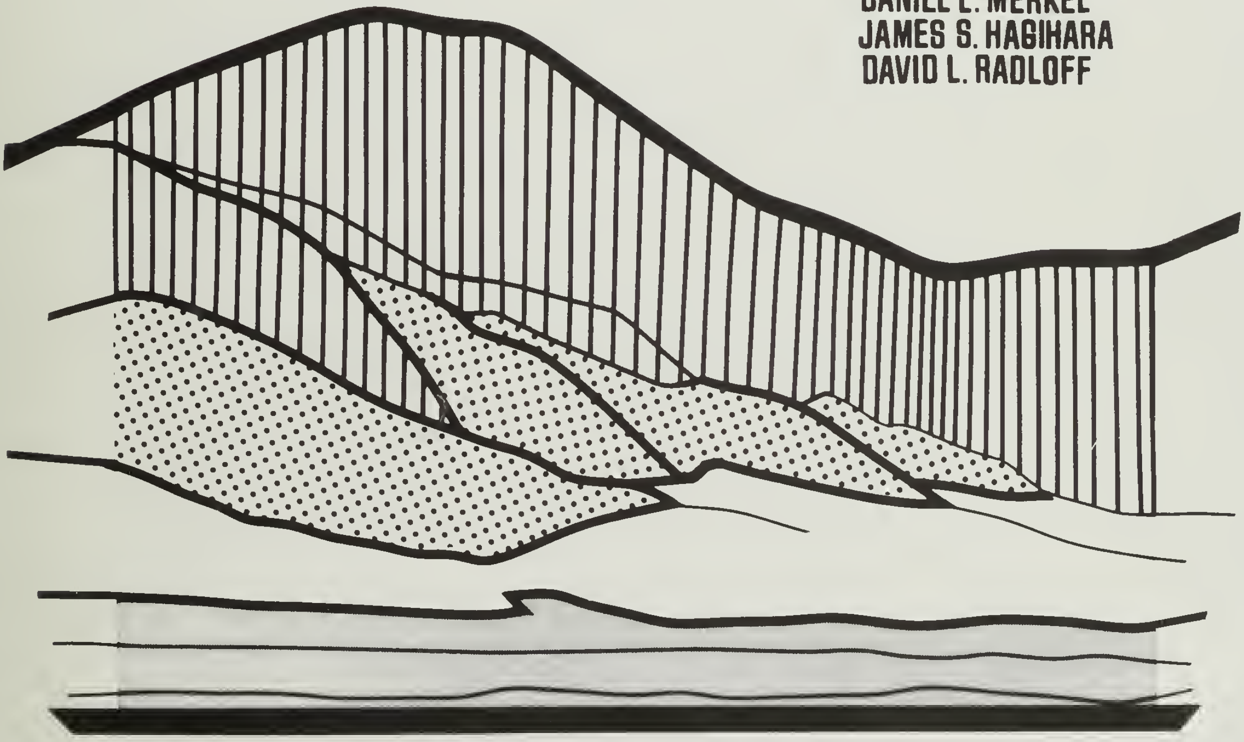

A COMPONENT LAND CLASSIFICATION FOR THE UNITED STATES: STATUS REPORT

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A COMPONENT LAND CLASSIFICATION FOR THE UNITED STATES: STATUS REPORT

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James S. Hagihara, and David L. Radloff

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Bureau of Land Management
U. S. Department of the Interior
Denver, Colorado

Research Summary

The framework of an ecological land classification system for the United States is described. This system consists of hierarchical classifications of four ecosystem elements: vegetation, soil, water, and landform, and a description for combining individual parts of each hierarchy into ecological units. The soil hierarchy has been fully developed and is described elsewhere. The framework for the vegetation element is discussed in detail in this bulletin. The water and landform hierarchies have not yet been fully developed; the current status of and plans for continued development of each is described in this bulletin. The system is flexible in that the individual or combined hierarchies provide for local, regional, or national resource assessments, appraisals, inventories, and program planning. The system is designed for coordinated land classification within and among land management agencies.

Acknowledgments

The authors thank the many people who have contributed to this document. The original concepts of the classification were developed by a Forest Service Task Group composed of Richard S. Driscoll, John W. Russell, and Marvin C. Meier.[1] Those concepts and the material in this publication have been influenced by previous publications, personal interactions with classification authorities, and extensive review and revision.

The present direction of this classification effort has been greatly influenced by the guidance provided by the agency heads of the USDI Bureau of Land Management, USDI Fish and Wildlife Service, USDA Forest Service, USDI Geological Survey, and USDA Soil Conservation Service. This group constitutes the five agency members of the Interagency Agreement Related to Classifications and Inventories of Natural Resources initiated in 1978. Their direction resulted from an Interagency Classification Technical Work Group which reviewed the status of the classification proposal in January 1979 and outlined future activities to complete the system.

An earlier draft of this publication was reviewed by over 100 individuals representing many federal and state agencies, universities, and other interested groups and organizations. Their suggestions have been incorporated to the fullest extent possible.

The document was reviewed and partially revised by nine individuals representing the five federal agencies and state government. The authors are indebted to these individuals who worked a week at the Rocky Mountain Station to resolve many questions: John Baker, USDI Bureau of Land Management; Harry N. Coulombe, USDI Fish and Wildlife Service; Kermit N. Larson and Robert D. Pfister, USDA Forest Service; Virginia Carter, USDI Geological Survey; Gary Nordstrom, USDA Soil Conservation Service; Loyola Caron and Stephen A. Miller, Affiliated State Organizations; and Richard Kleckner, representing the Five Agency Policy Group.

Several other people have contributed significantly to preparation of this document. These include Donald O. Meeker, Darrell L. Gallup, Terry T. Terrell, Dale Snyder, and Robert Bailey.

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[1]Driscoll, Richard S., John W. Russell, and Marvin C. Meier. 1978. Recommended national land classification system for renewable resource assessments. 44 p. Unpublished report on file at Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Preface

In 1978 five federal agencies signed the "Interagency Agreement Related to Classifications and Inventories of Natural Resources." The five agencies are USDA Forest Service and Soil Conservation Service, and USDI Bureau of Land Management, Fish and Wildlife Service, and Geological Survey. Provisions have been made under the agreement to obtain input from participating state organizations. Throughout this report, reference will be made to this agreement as the "Interagency Agreement."

The principal objectives of the Interagency Agreement are (1) to provide guidelines and to assure administrative action to minimize duplication of resource management efforts, (2) to enhance and encourage compatible data collection and data sharing, (3) to promote resource appraisal efficiency and management program compatibility, and (4) to expedite technology transfer. One of the initial issues of the agreement is development of a uniform land classification system. The system is required to (1) assure uniform accounting of land area, (2) facilitate information exchange among renewable natural resource management agencies and organizations, (3) assist in developing resource assessments and management of programs, (4) provide a framework for organizing information about the land.

This report presents the current development status of an ecological land classification for the United States that will assist in providing these needs. It describes work by the Resources Evaluation Techniques Program and two Interagency Agreement Strategy Groups in development of a uniform land classification framework and identifies items for continuing research and development in land classification. When complete, the classification is intended to provide a uniform taxonomy for classifying the land according to its soil, vegetation, landform, and water features. It is designed to help organize knowledge related to the inherent capability of the land to produce a variety of resources.

The vegetation element is based on climax (potential natural) vegetation with identified relationships between climax and existing vegetation. The soil component is Soil Taxonomy (Soil Survey Staff 1975), which is currently in use throughout the United States. The conceptual taxonomic hierarchies for water and landform are discussed briefly. Also presented is a process for combining components to define and describe ecological land units.

When complete, the classification can provide for uniform site identification. The system will then provide more succinct definitions of the individual elements and ecological land units for use by resource inventory specialists, resource analysts, land use planners, and land managers. As additional work is completed, additional reports will be published.

The process of developing a classification to deal with the inherent capability of the land to produce a variety of renewable resources is complex. The development includes review, testing, and modification. Readers are encouraged to review critically the classification framework presented here. Specific comments and suggestions concerning the classification may be referred to the Classification Project Leader, Resource Evaluation Techniques Program, Rocky Mountain Forest and Range Experiment Station, 240 West Prospect Street, Fort Collins, CO 80526.

CONTENTS

A Component Land Classification for the United States: Status Report

by Richard S. Driscoll, Program Manager;
Daniel L. Merkel, Range Conservationist;
James S. Hagihara, Research Management Coordinator;
and David L. Radloff, Research Forester[2]

Introduction

Classification is the process of grouping things on the basis of similarities. A classification forms a framework for organizing knowledge about things, whether they are living organisms, cultural objects, or parcels of land. The specific structure of a classification is strongly influenced by its intended use, expressed or implied. The objective in the development of the framework for this classification was to base it on ecological principles rather than on specific use of resources. The individual users can then draw on selected parts of the system to make the necessary interpretations to meet specific needs.

The task of identifying inherent potential or natural capability of the land to produce a variety of resources is a common problem faced by land management agencies. To satisfy the needs of national renewable resource appraisals and assessments, there must be a uniform procedure for judging present conditions against inherent potential or capability. A uniform framework for classifying the inherent potential of the land will also (1) aid consistent evaluation of the Nation's renewable resource base, (2) contribute to uniform guidelines for data collection and exchange, (3) facilitate uniform program planning, and (4) increase application of research results.

Evidence of this current need is partially reflected in recent legislation, including the Forest and Rangeland Renewable Resources Planning Act of 1974, the National Forest Management Act of 1976, the Federal Land Policy and Management Act of 1976, and the Soil and Water Resources Conservation Act of 1977.

Identifying inherent productivity is only part of the classification problem that needs to be addressed, however. Procedures are also needed to enable identification of landscape characteristics such as existing vegetation, current land use, and other dynamic aspects of the land and water resource base. Classification of these "nonpermanent" land features are not described in this report.

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[2]Driscoll and Radloff are employees of the U.S. Department of Agriculture, Forest Service Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo. Merkel is an employee of the U.S. Department of Agriculture, Soil Conservation Service, assigned to the Rocky Mountain Station. Hagihara is an employee of the U.S. Department of Interior, Bureau of Land Management, assigned to the Rocky Mountain Station. The research reported here was conducted by the Resource Evaluation Techniques Program at the Rocky Mountain Station. The Station's headquarters is in Fort Collins, in cooperation with Colorado State University.

The classification framework reported herein is the result of efforts started in the early 1970's. ECOCLASS[3] outlined a methodology for classifying ecosystems using a component mapping approach. ECOCLASS identified three components: (1) potential vegetation, (2) land system (Wertz and Arnold 1972), and (3) aquatic system. In ECOCLASS, habitat type (land area characterized by a single climax plant association) was included as a unit of the vegetation system. The ECOCLASS land system included both landform and soils criteria as part of a single mapping hierarchy.

Modified ECOCLASS[4] replaced habitat type with plant association in the vegetation system. The land system was separated into two components--landform and soil. Neither ECOCLASS nor Modified ECOCLASS clearly distinguished between taxonomic and mapping concepts of classification.

Driscoll (et al.)[1] recommended a "National Land Classification System For Renewable Resource Assessments" that incorporated many concepts of Modified ECOCLASS. This classification was designed for the current forest and rangeland base of the United States where native vegetation persists. This included approximately 1.7 billion acres of the 2.4 billion acres of the United States' land and water area. It did not include cropland, improved pasture, and built-up areas.

The classification described in this paper builds on the concepts from these earlier efforts and incorporates some changes based on experience from reviews and field tests of the other classifications.

The classification is a consistent taxonomic framework. Classes are defined on the basis of specified factors, regardless of association with adjacent areas, so each taxonomy describes discrete types that are place-independent (Bailey et al. 1978). The individual taxonomies provide a standard language for (1) communication, (2) identification and naming of classes, and (3) defininition of criteria for inventory and mapping systems.

The component taxonomic approach offers three important features for application to renewable resource management: (1) Homogeneous units can be identified at different levels of the hierarchical framework; (2) flexibility is offered to aggregate data through different hierarchies for different uses; and (3) individual class data can be aggregated through other hierarchies based on geographical relationships (such as administrative units or natural regions).

The individual components synthesize much information about various aspects of the land resource. Each is a classification in its own right and can be used individually. Alternatively, features of several components can be used in combination to more completely describe the total environment of a land unit.

The system is flexible by allowing the manager to apply only those components and levels that are needed for an intended use. It is not necessary that all components

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[3]ECOCLASS Task Force. 1973. ECOCLASS--A method for classifying ecosystems. p. 1-52. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah. (Mimeo).

[4]Modified ECOCLASS Committee. 1977. Modified ECOCLASS--a method for classifying ecosystems. 87 p. USDA Forest Service, Region 2, Region 3, and Rocky Mountain Forest and Range Experiment Station, ad hoc committee. (Mimeo).

be applied for all management applications. Nor is it necessary that the most detailed level of classification be used if some more general level is sufficient. However, the ability to use this flexibility can be limited by the availability of data. Therefore, it is important that inventory data be identified to the lowest level practical.

In ecological land classification, integration implies joint consideration of the variety of environmental factors that interact to create characteristic land units or regions. An ideal ecological land classification might be a single hierarchy whose units are defined in terms of all identifiable environmental factors. This ideal can only be approximated. To develop such a hierarchy would require a high level of understanding of ecosystem functioning--and an equally high level of agreement among users on specific criteria selected to define units at each hierarchic level.

The component approach to land classification permits an approximation of integrated land classification yet retains flexibility for users to employ a single component hierarchy where it adequately meets a specific need. In the component approach, ecological integration is first approximated by the individual hierarchies. Each component taxonomy represents an integration of physical and biological environmental factors. Classification criteria from several component hierarchies may be combined to increase the scope of the integration.

This second stage of integration is a purely descriptive approach. Combining characteristics from more than one component defines a new taxonomic unit. This new unit is a very specifically defined category--and is assumed to represent a homogeneous ecological taxonomic unit. These combined-attribute units are termed "ecological response units." Specifically, an ecological response unit is defined as "a unit composed of characteristics of two or more components." The categories whose characteristics are combined may be from similar hierarchic levels. Because they share common environmental features, all representatives of an ecological response unit should behave in a predictable manner to both natural changes and to resource management practices.

An ecological response unit is a specific category by which individual land units can be identified. It does not necessarily represent a mapping unit, a contiguous geographic area, nor a specific geographic locale. Respresentatives of an ecological response unit may occur scattered throughout the landscape mosaic. Wherever areas belonging to the same ecological response unit occur, environmental conditions are assumed to be equivalent.

To manage land as an ecosystem, it is necessary to understand the functioning of its components. This requires the ability to identify and describe the land in terms of its individual components. A taxonomic component classification enables this identification. The components incorporated in this land classification framework represent relatively permanent features of the landscape: soil, landform, climax (potential natural) vegetation, and water. Acting together, these components account for much of the inherent capability of the land to produce a variety of renewable resources. In addition, certain management-oriented considerations are incorporated in the classification to make it useful to land managers in making land use and treatment decisions.

The following specific criteria were established to guide the development of this classification framework:

1. The classification system should be based on permanent land features. This provides a basis to define land classes in terms of inherent potential for resource production (Hirsch et al. 1978).

2. The system should be a national framework that assures to the extent possible compatibility and consistency with existing classification systems (Hirsch et al. 1978).

3. The system should provide complete classification of the area of concern (Witmer 1978).

4. The system should retain open-endedness and flexibility so additional levels or classification components can be added (Witmer 1978).

5. The classification should be hierarchical so, through aggregation and disaggregation, it can provide decisionmaking information at several geographic or administrative levels (Nelson et al. 1978).

6. The classification should be based on ecological principles and should enable identification of land units that are expected to respond in a similar, predictable manner when influenced by natural or man-caused events.

7. The classification should be based on measurable or readily inferable features of the land so identification of sites is consistent and repeatable.

8. The framework should be capable of functioning in readily accessible, computer-operated information systems (Frayer et al. 1978).

9. The classification must be technically sound and should be experimentally validated (Frayer et al. 1978).

Figure 1 illustrates the basic structure of the classification system reported herein. Information concerning resource characteristics becomes progressively more specific as one proceeds downward from the highest level or category of the hierarchies. The lowest levels of the hierarchies are well suited for detailed project planning; higher levels are better suited for national, regional, or state resource assessments and planning.

Vegetation component	Soil component	Landform component[1]	Water component[1]
Class	Order		
Subclass	Suborder Great Group		
Formation	Subgroup		
Series	Family		
Association	Series		

[1]To be completed.

Figure 1. Basic components and levels of the Land Classification system as completed.

Soil Component

Soil Taxonomy (Soil Survey Staff 1975) was adopted as the soil component in this classification system. This system, which is used by the National Cooperative Soil Survey, had its inception in the mid-1940's.

The soil taxonomy is complete with respect to the framework, format, and definitions of most categories and classes of the system. The classification of some soils, such as tropical soils and organic soils, needs further development and testing. Soil Taxonomy will be revised and updated as needed by the USDA Soil Conservation Service, Soil Survey Staff.

It is a hierarchical system in which presently identified soils in the United States are precisely defined by observable and measurable soil properties. The properties can be related to soil formation as affected by parent material being acted upon by organisms, relief, and climate over time.

Brief descriptions of the six categories of the soil taxonomy follow:

Orders.--There are 10 orders defined by the presence or absence of identifiable horizons that reveal the major soil-forming processes, such as accumulation of organic matter.

Suborders.--There are 44 suborders defined by important properties that influence soil development and plant growth, such as wetness and major kinds of parent material

Great Groups.--There are 186 great groups defined by similarities in kind, arrangement, and distinctiveness of horizons as well as close similarities in soil, moisture, temperature regimes, and base status.

Subgroups.--There are 987 subgroups defined by characteristics already described for the higher classes. These characteristics are subordinate because their presence modifies the dominant soil-forming processes.

Families.--There are 5417 families defined by physical and chemical characteristics that affect soil use and response to management. Particle size, mineralogy, temperature regime, and depth of root penetration are examples.

Series.--There are about 12,000 series recognized by the kind, thickness, number, and arrangement of horizons. The range of properties, such as particle size, used to define series may be more restrictive than those used at the family level.

Phases of soil series are functional groupings created to serve specific purposes in individual soil surveys. They are not part of the soil taxonomic hierarchy. Any property or combination of properties that does not duplicate class limits for a class can be used to differentiate phases. The choices of properties and limits are determined by the purpose of the particular soil survey and by how consistently the phase criteria can be applied. Some of the features commonly used in defining phases in soil surveys are texture of the surface layer; presence of rock fragments, such as gravel or stones; slope; climatic characteristics, such as moisture and temperature; salinity; kind of substratum; erosion or flooding potential.

Water Component

A water classification should provide a framework to group relatively permanent water features according to their ability to support life on and in the water. An initial draft framework for such a system was completed by an interagency strategy group in 1980. The system outlined a process for recurrent inventories to monitor changes in the quantity and quality of water resources rather than to reflect the inherent potential of water to serve as a habitat or a resource. Review and field evaluations during 1980 and 1981 indicated that further work is needed before the classification for the water hierarchy is presented.

The interagency strategy group examined the literature on existing classifications that may be incorporated or act as guides in developing a system. It was found that classification systems for river and river zones are based on dominant fish species, longitudinal distribution of benthic fauna, degree of productivity, nature of source, stream order, and selected chemical and physical characteristics (Pennak 1971, Hawkes 1975, Hynes 1970). Worldwide classification systems such as those of Illies and Botosaneau (1963) and Pennak (1971) are based on multiple characteristics and utilize more universal criteria than local and regional systems. Classifications for lakes are generally based on geographical, hydrological, mixing, and trophic characteristics (Hutchenson 1957, Wetzel 1975, Winter 1977, Cole 1978, Wentz 1980). The only national classification systems which include wetlands are Martin (et al. 1953), Anderson (et al. 1976), and Cowardin (et al. 1979). These classifications are based on vegetation, soil, and hydrology. Estuaries have been classified according to topography (Pritchard 1952), salinity structure (Pritchard 1955, Cameron and Pritchard 1963), and stratification (Dyer 1973). There are also many land classification systems which incorporate water-related parameters and water bodies (Rowe 1971, Anderson et al. 1976, Bailey et al. 1978, West and Shute 1978, Platts 1980).

An existing classification was not found that met the precise needs of the water component. Several systems have philosophies, definitions, or characteristics which would be useful in describing the water component. The most useful existing classification for developing the upper levels of the classification scheme is the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979). Certain portions of the Cowardin et al. (1979) system, as well as information from other classifications, are being further evaluated for developing the water element.

Water is an exceedingly dynamic landscape feature with characteristics that fluctuate frequently and rapidly. In wetlands, vegetation and soils influence the fluctuations in water regime and the chemical and physical characteristics of water. Because of this variation, all three components--water, soils, and vegetation--are needed to identify wetlands (Cowardin et al. 1979). Climatic variations are reflected in the extent that surface flooding or water table fluctuations influences the extent and location of water bodies. Classification of water bodies in a component system should be based on characteristics of water to support life on and in the water. Information on associated soils and vegetation would be used as descriptors or modifiers of the water system.

Further development of a water classification includes the following objectives:

1. To provide a mechanism for comparing and contrasting water units, for evaluating their utility to support life on and in the water and for grouping similar sites, subsystems, or systems on the basis of their water-related physical and chemical characteristics.

2. To provide an open-ended, flexible classification system to be one component of the classification framework for the purpose of providing assessment, management, and planning information for renewable natural resources.

3. To provide an ecosystem-oriented, multiple-level framework for inventory or collection of water-related information for any site in the United States.

4. To provide a classification system which can be interfaced directly with computer-based information systems for storage, retrieval, and manipulation of data.

Landform Component

A single landform classification acceptable and suited to the needs of all land management agencies and individuals has not yet been identified. In March 1979, a study was initiated to explore possible alternatives for development of a landform classification that would meet land and resource management needs.[5] Initially, 18 existing systems were selected for analysis. From an evaluation of these, four were identified for field testing. These were evaluated by mapping in Grand County, Colo., during the summer of 1980.

This evaluation indicated that no existing system can, by itself, provide a consistently organized hierarchical landform classification system. The process for developing a suitable classification that includes all three types of information (morphometric, surficial materials, and genesis), combining the best features of existing systems, is continuing.

Landforms are visible features of the earth's surface such as mountains, hills, valleys, and plains. Landforms are ecologically significant because they influence environmental factors such as water retention or release and exposure to solar energy. As such, they represent an important component of an ecological land classification (Bailey 1981). Landforms can be classified according to external form (morphometrics), surficial materials, or formative processes (genesis).

Morphometric information (e.g., slope, aspect, elevation, relief) is applicable to a broad range of specific problems. These include timber harvesting, road and trail construction, soil erodibility, visual analysis, hydrology, recreation, fire control, and grazing use.

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[5]Lynch, Dennis L., and Lawrence G. Kolenbrander. 1981. A methodology for testing the application of selected landform classification systems for renewable resource assessment and planning. Unpublished report on file at Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Surficial materials information (e.g., types and sizes of unconsolidated materials, types of bedrock) is used in estimating the effects of different land uses on the landscape in terms of soil erosion, vegetation production, hydrology, and hazard and stability conditions. Surficial materials also affect the planning and execution of engineering and construction projects, including site or route selection and costs of construction.

The origin or genesis of landform features can provide information regarding the process of formation and thus an evaluation of the types of materials involved. It also provides an interpretation of potential stability under contemporary geomorphic processes and proposed management treatments.

Vegetation Component

Climax (potential natural) vegetation is the foundation for this component. As used here, climax connotes relatively stable vegetation in dynamic equilibrium with its physical and biotic environment (Selander 1950, Mueller-Dumbois and Ellenberg 1974). This concept may also be described as the "potential vegetation determined primarily by climate and soil in the absence of man's influence" (Daubenmire 1978). Because climax vegetation is in dynamic equilibrium with its environment, it serves as an expression of the integrated effect of environmental factors that influence vegetation development.

Description of the Hierarchy

The vegetation component is a six-level hierarchy (fig. 1). The levels are class, subclass, group, formation, series, and association.
The upper four levels are patterned after the UNESCO[6] world vegetation classification (UNESCO 1973). These levels are based primarily on vegetation physiognomy (growth form and outward appearance) modified at some levels by ecological factors. Some criteria of the upper four levels have been modified from the UNESCO classification to facilitate consistent identification of types. The upper four levels (class, subclass, group, and formation) are shown in the appendix. The two lower levels, series and association, are based on more detailed analyses of the plant communities.

Descriptions of the six categories of climax vegetation component follow:

Class.--There are five mutually exclusive classes based on dominant growth form and cover.

I. Forest: Communities formed by trees.[7] Canopy coverage is 61% or greater at maturity.

II. Woodland: Composed of trees. Canopy coverage is 26-60% at maturity. A herbaceous and/or shrub understory is usually present. (This class includes the "open-forest" of some authors).

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[6]United Nations Educational, Scientific, and Cultural Organization.

[7]For the purposes of this classification, a tree is a woody perennial, usually single stemmed plant that has a definite crown shape and characteristically reaches a mature height of at least five meters (16 feet); this size requirement may be altered where ecological research provides a basis for adjustment. Some species of oak (Quercus), juniper (Juniperus), willow (Salix) and other plants may grow as either trees or shrubs.

III. Shrubland: Composed of woody perennial plants, generally with multiple stems, 0.5-5 m tall at maturity (shrubs) with 26% or more canopy coverage. A tree canopy cover 25% or less may be present.

IV. Dwarf-shrubland: Communities with 26% or more canopy coverage of woody perennial plants rarely exceeding 0.5 m in height at maturity. Tree or shrub canopy cover 25% or less may be present.

V. Grassland/Herbaceous: Communities dominated by grass, grasslike, or forb vegetation with or without a tree or shrub component at maturity. This includes emergent and floating aquatic herbs. Tree or shrub canopy cover, if present, 25% or less at maturity.

Subclass.--There are 19 subclasses in the United States. Tree and shrub separations at this level of the classification are based on morphologic characters, such as evergreen and deciduous habit, or on adaptions to temperature and water. The separations for grassland are made on the basis of morphology and relative height of graminoid (grasslike) vegetation. (Tall graminoid vegetation is more than one m tall; medium is over 0.5 m tall and up to 1 m tall; and short is 0.5 m tall or less).

Group.--There are 62 groups in the United States. The separations are based on different criteria for each class: forests are subdivided by generalized climatic regimes (e.g., tropical, temperate, subpolar) and morphologic features; woodlands are subdivided mainly by leaf morphology; shrublands are subdivided by leaf morphology and climatic factors; dwarf-shrublands are subdivided by coverage, associated life forms, ecological features, and other characteristics; and the grasslands are subdivided by associated life-form layers and height of life-form.

Formation.--There are 150 formations in the United States. The criteria vary considerably for identifying types at the formation level. The criteria include tree crown shape, density of shrub growth, growth form of grasses, and a variety of ecological or environmental factors. Not all of the United States formations have been identified or described. Therefore, the formation list in this paper is incomplete.

Series.--The series is a grouping of climax plant associations that usually have a common climax dominant species. Procedures for developing a series level taxonomy for forest vegetation are illustrated by Pfister and Arno (1980) and for shrublands and grasslands by Mueggler and Stewart (1979). These procedures define both associations and series. There are some instances when climax dominance is uncertain. In these cases, co-dominance is recognized and the communities are characterized and identified accordingly.

Association.--Associations are plant communities of definite floristic composition, representing a uniform appearance and growing in uniform habitat conditions (Daubenmire 1968). Associations are groupings of plants that have attained dynamic equilibrium with local existing environmental conditions. Herbaceous, shrubby, and tree life forms contribute to the definitions and descriptions of associations. They are developed by sampling representative climax or near-climax stands and grouping stands on the basis of floristic, dominance, and ecologic similarities. Associations are conventionally named for conspicuous dominant species in different layers. Codominance can be explicitly recognized by including more species in the association name. A diagnostic indicator species may be used in the association name to provide a clearer link between the association characteristics and the name.

Inventory identifies the existing plant community. In some instances, classification of existing plant communities is required, such as classification of agricultural plant communities for different kinds of crop production estimates or classification of plant nurseries used for seed production or transplant material. Ecologists and other vegetation specialists link these kinds of existing plant communities to climax communities through (1) generalized inferences from surrounding native vegetation, (2) utilizing soils information from soils existing under the existing agricultural land communities to similar soils under native communities, (3) referring to maps such as presented by Küchler (1964), or (4) historical records.

The land manager may need to know the location and extent of cultural communities such as areas of afforestation and rangeland seedings for resource monitoring and management. The link of these cultural communities to climax communities can be similar to that between agricultural communities and climax vegetation.

Although knowledge of existing natural vegetation is needed, existing vegetation, in itself, does not always reflect inherent site potential. Existing natural vegetation occurs as infinite successional stages which are related to causes of disturbance (i.e., timber harvesting, livestock grazing, or unnatural wildlife population concentrations) and time since disturbance. Early successional stages (seral communities) present an infinite array of communities, especially at lower levels of a classification hierarchy, and are abundantly represented in most areas of the United States. Late successional stages (near-climax to climax communities) are less common or rare.

Only the climax or latest stable successional community reliably reveals the biological potential of an area. Therefore, classifications based on climax or near-climax vegetation are powerful, integrated expressions of the inherent natural biological capability of areas. Consequently, the analysis and classification of climax or near-climax vegetation provides a means of interpreting the relationship of existing vegetation communities to each other, permits identification of potential trends in vegetation toward or away from climax or near-climax vegetation, and allows for functional and interdisciplinary management decisions on alternative resource uses and allocations.

A matrix (fig. 3) illustrates the relationships between existing and climax vegetation. In the examples, each row shows some successional vegetation communities that occur within particular climax vegetation series. The left column shows the climax vegetation series which may support several existing vegetation communities. Acreage data for appropriate cells in the matrix can be provided by an inventory of existing vegetation where the climax vegetation has been identified. Knowing the position of a specific successional community within the matrix in relation to its climax potential enables prediction of natural succession or trends resulting from different management treatments. Also, it connotes information about the natural biological potential of the existing vegetation. Similar matrices can be developed for grasslands and shrublands. Shiflet (1973) has adequately discussed how existing plant communities are interpreted and linked to climax or near-climax community classification.

In the context of both examples, the principal objectives are to (1) identify the existing natural vegetation community obtained through inventory, (2) interpret it in relation to climax or near-climax vegetation for the area, (3) evaluate management objectives for the area, and finally, (4) establish management goals. For example, existing vegetation may be a shrub-grass seral community within an area with climax grassland potential. Evaluation of management alternatives may result in a decision to "hold" the existing community in its present seral stage for combined wildlife-livestock-water production, use, and protection. Or, local and national issues may favor managing for livestock grazing or maintenance and improvement of wildlife habitat. Decisions can then be made to manipulate the existing plant community by changing management objectives or land treatments to address the issues and meet management goals. This is accomplished as a result of knowledge of climax vegetation and the identification of the positions of the existing seral stage in relation to its successional status.

The value of both existing vegetation classification and climax vegetation classification should be recognized. Both are important and widely used. In combination, they are an especially valuable tool for understanding and managing the vegetation resource and the area on which it is produced.

EXISTING VEGETATION

Climax Series	*Pinus ponderosa* (Ponderosa pine)	*Pseudotsuga menziesii* (Douglas-fir)	*Abies grandis* (Grand fir)	*Pinus contorta* (Lodgepole pine)	*Larix occidentalis* (Western larch)
Pinus ponderosa	Climax	--	--	--	--
Pseudotsuga menziesii	Seral	Climax	--	Seral	Seral
Abies grandis	Seral	Seral	Climax	Seral	Seral

Figure 3. The relationships between existing vegetation (cover types) and climax vegetation at the series level for western Montana (after Pfister et al. 1977).

Application of the Classification

The application of the classification can be accomplished by using each component or through the concept of an ecological response unit. Integration by the use of ecological response units can be clarified by referring to the example in figure 4. Only the soil and vegetation components are used in the illustration. The concept may be extended to more than two components, however. In the example (fig. 4), the most specific and therefore homogeneous ecological response unit is "Abies lasiocarpa/ Vaccinium scoparium-Peeler."

Climax Vegetation		Soil	
CLASS	Forest	ORDER	Alfisol
SUBCLASS	Mainly evergreen forest	SUBORDER	Boralf
Group	Temperate and subpolar evergreen needle-leaved forest	GREAT GROUP	Cryoboralf
FORMATION	Temperate and subpolar evergreen needle-leaved forest with conical crowns	SUBGROUP	Typic Cryoboralf
SERIES	Abies lasiocarpa[1]	FAMILY	Fine-loamy, mixed Typic Cryoboralf
ASSOCIATION	Abies lasiocarpa/ Vaccinium scoparium[2]	SERIES	Peeler

[1]Subalpine fir.

[2]Grouse whortleberry.

Figure 4. Examples of categories in the soil and climax vegetation hierarchies. Combining the two components at the lowest levels creates an ecological response unit named "Abies lasiocarpa/Vaccinium scoparium-Peeler." Each location where this plant association and soil series occur together is a member of the same ecological response unit. Categories whose characteristics are combined to form an ecological response unit could be from similar hierarchic levels of each classification used. However, caution is required in establishing the units on a 1:1 relationship between hierarchic levels of each component due to compensating and limiting environmental factors. An association may occur on one or more soil taxonomic unit or a soil taxonomic unit may support more than one vegetation association.

Information about this and related ecological response units can be aggregated using either the climax vegetation or soil hierarchy. Either the vegetation category "Abies lasiocarpa" or the soil category "fine-loamy, mixed Typic Cryoboralf" includes the "Abies lasiocarpa/Vaccinium scoparium-Peeler" sites. However, each component hierarchy will result in aggregating different groups of ecological response units. This gives flexibility to the aggregation procedure, allowing the user to choose the specific hierarchic combination that is best for a particular management information need.

The classification described here may be used to design conventions to inventory and map natural resources. Maps portray the location and extent of landscape features. They show the spatial interrelationships of landscape components. Some maps represent taxonomic units as mapping units. Although some large-scale maps represent each classified category as a mapping unit, this is usually impractical on smaller scales.

A formal taxonomy provides a reference for defining the elements of mapping units (Küchler 1951).

It is important to recognize that taxonomic and mapping approaches to land characterization are distinct but related processes. Both attempt to integrate many environmental factors, but the integration is achieved in different ways. Each approach can help answer different questions about the land resource. The taxonomic classification allows for uniform identification and description of consistently taxonomic units and provides a framework for mapping. Mapping locates the units and portrays the spatial interrelationships among them. It allows aggregation and disaggregation of ecosystem information on a geographic basis. Therefore, both approaches are useful and necessary to organize the variety of information needed to develop a full understanding of the resource and to allow efficient renewable resource management.

Recognized Research Needs

Plans for completion and implementation of the classification include a number of tasks to be accomplished through the combined efforts of research, development, and user agencies and groups. The activities include the following:

1. Complete an analysis of the resource management needs and purposes for a hierarchic, ecological land classification. The analysis should consider the relationship of this classification to others. This analysis can guide future refinements to the classification described herein and identify other classification needs.

2. Test the classification reported herein for field applications at diverse locales.

3. Examine and develop approaches to ecological integration and aggregating data identified by integrated classes.

4. Evaluate criteria used for resource mapping to determine how the component taxonomies are related to mapping units currently being used.

5. Study intercomponent relationships (e.g., soil series and vegetation association) to advance the understanding of the ecological integration inherent in the components.

6. Refine the vegetation component by (a) establishing a continuing effort to develop climax vegetation taxonomies for many locales, (b) standardizing the methodology and correlating activities for identifying and naming categories at all levels of the hierarchy, (c) analyzing the relationship between climax and existing vegetation for several diverse areas, (d) evaluating the utility of the Group and Formation levels, and (e) examining the need for a hierarchic level between the Formation and the Series.

7. Fully analyze the needs and purposes for landform and water hierarchies.

8. Establish a continuing program to provide assistance to agencies in implementing uniform and complimentary land classification.

SELECTED REFERENCES

Anderson, J. R.; Hardy, E. E.; Roach, J. T.; Witmer, R. E. A land use and land cover classification system for use with remote sensor data. Professional Paper 964. U.S. Department of Interior, Geological Survey; 1976. 28 p.

Bailey, R. G. Ecoregions of the United States (with map). Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Sta_ tion; 1978, 77 p.

Bailey, R. G. The landform component in land classification. In: Resource Evaluation Newsletter 8. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1981. 3-5 p.

Bailey, R. G.; Pfister, R. D.; Henderson, J. A. Nature of land and resource classification--a review. J. For. 76:650-655; 1978.

Cameron, W. M.; Pritchard, D. W. Estuaries. In: Hill, M. N., ed. The Sea. v. 2. New York, NY: John Wiley and Sons; 1963: 306-324.

Cole, G. A. Lake classification--good and bad. In: Marmelstein, A., ed. Proceedings, National Symposium, Classification, Inventory, and Analysis of Fish and Wildlife Habitat. Washington DC: U.S. Department of Interior, Fish and Wildlife Service; 1978. 67-78 p.

Cowardin, Lewis M.; Carter, Virginia; Golet, Francis C.; LaRoe, Edward T. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1979: 103 p.

Daubenmire, R. Plant communities: A textbook on plant syneology. New York, NY: Harper and Rowe; 1968. 300 p.

Daubenmire, R. Plant geography with special reference to North America. New York, NY: Academic Press; 1978. 338 p.

Dyer, K. R. Estuaries: A Physical Introduction. New York, NY: John Wiley and Sons, Inc.; 1973. 140 p.

Frayer, W. E.; Davis, L. S.; Risser, P. G. Uses of land classification. J. For. 76:647-649; 1978.

Hawkes, H. A. River zonation and classification. In: Whitton, B. A., ed. River ecology. Studies in ecology. v 2. Berkeley, CA: University of California Press; 1975. 312-374.

Hirsch, A.; Cushwa, C. T.; Flach, K. W.; Frayer, W. E. Land classification--where do we go from here? J. For. 76:672-673; 1978.

Hutchinson, G. E. A treatise on limnology. v. 1. London: John Wiley and Sons, Inc.; 1957. 1015 p.

Hynes, H. B. N. The ecology of running waters. Toronto, Ontario, Canada: University of Toronto Press; 1970. 555 p.

Illies, J.; Botosaneau, L. Problems et methodes de la classification et de la zonation ecologique des aux courantes, considerees surtout du pont de vue faunistique. International Association Theoretical Applied Limnology Communication 12. (In French); 1963. 57 p..

Küchler, A. W. Relation between classifying and mapping vegetation. Ecology 32:275-283; 1951.

Küchler, A. W. Potential natural vegetation of the conterminous United States. American Geographic Society Special Publication 36. (Revised map 1975); 1964. 116 p.

Martin, A. C.; Hotchkiss, N.; Uhler, F. M.; Bourn, W. S. Classification of wetlands of the United States. U.S. Department of Interior, Fish and Wildlife Service Special Scientific Report--Wildlife 20; 1953. 14 p.

Mueggler, W. F.; Stewart, W. L. Grassland and shrubland habitat types of Western Montana. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1979. 154 p.

Mueller-Dumbois, D; Ellenberg, H. Aims and methods of vegetation ecology. New York, NY: John Wiley and Sons; 1974. 547 p.

Nelson, D.; Harris, G. A.; Hamilton, T. E. Land and resource classification--who cares? J. For. 76:644-646; 1978.

Pennak, R. W. Toward a classification of lotic habitats. Hydrobiologia 38(2):321-334; 1971.

Pfister, R. D.; Arno, S. F. Classifying forest habitat type based on potential climax vegetation. For. Sci. 26:52-70; 1980.

Pfister, R. D.; Kovolchik, B. L.; Arno, S. F.; Presby, R. C. Forest habitat types of Montana. Gen. Tech. Rep. INT-34. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1977. 174 p.

Platts, W. S. A plea for fishery habitat classification. Fisheries 5(1):2-6; 1980.

Pritchard, D. W. Estuarine hydrography. Advanced Geophysics 1:243-280; 1952.

Pritchard, D. W. Estuarine circulation patterns. Proceedings American Society Civil Engineers 81(717):1-11; 1955.

Rowe, J. S. Revised working paper on methodology/philosophy of ecological land classification in Canada. Proceedings second meeting Canadian Commission Ecological Land Classification:23-30; 1971.

Selander, S. Floristic phytogeography of southwestern Lule Luppmank. Acta Phytogeographica Succica. 27:1-200; 1950.

Shiflet, T. N. Range sites and soils in the United States: Arid shrublands. Proceedings of the third workshop of the United States/Australia Rangelands Panel. Tucson, AZ: Society for Range Management Publication. 1973. 26-33 p.

Soil Survey Staff. Soil Taxonomy: A basic system for making and interpreting soil surveys. Agriculture Handbook No. 436. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service; 1975. 754 p.

United Nations Educational, Scientific, and Cultural Organization. International classification and mapping of vegetation, Series 6, Ecology and Conservation. Paris, France; 1973. 92 p.

Wentz, D. A. Lake classification--is there method to this madness? Geological Survey Quality of Water Branch Technical Memorandum No. 80.09. Habitat. Washington, DC: U.S. Department of Interior, Geological Survey; 1980. 17 p.

Wertz, W. A.; Arnold, J. F. Land systems inventory. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1972. 12 p.

West, N. E.; Shute, D. A. Alternatives for ecosystem classification and their implications for rangeland inventory. Proceedings of the first International Rangeland Congress:174-176; 1978.

Wetzel, R. G. Limnology. Philadelphia,PA: W. B. Saunders Co.; 1975. 658 p.

Winter, T. C. Classification of the hydrologic setting of lakes in the north central United States. Water Resources Research 13(4):753-767; 1977.

Witmer, R. E. U.S. Geological Survey land-use and land-cover classification system. J. For. 76:661-666; 1978.

APPENDIX

Appendix.--Upper four levels of the vegetation component (patterned after UNESCO 1973)

CLASS	SUBCLASS	GROUP	FORMATION
I. Forest (trees over 5 m tall forming 61% to 100% canopy coverage)	A. Mainly evergreen forest	1. Tropical rain forest	a. Tropical lowland rain forest
			b. Tropical submontane rain forest
			c. Tropical montane rain forest
			d. Tropical "subalpine" rain forest
			e. Tropical (rain) cloud forest
			f. Tropical alluvial rain forest
			g. Tropical swamp rain forest
			h. Tropical evergreen bog forest
		2. Tropical and subtropical evergreen seasonal	a. Tropical or subtropical evergreen seasonal lowland forest
			b. Tropical or subtropical evergreen seasonal submontane forest
			c. Tropical or subtropical evergreen seasonal montane forest
			d. Tropical or subtropical evergreen dry "subalpine" forest
		3. Tropical and subtropical semideciduous	a. Tropical or subtropical seimideciduous lowland forest
			b. Tropical or subtropical semi deciduous montane or cloud forest
		4. Subtropical rain forest	a. Subtropical lowland rain forest
			b. Subtropical submontane rain forest
			c. Subtropical montane rain forest
			d. Subtropical "subalpine" rain forest
			e. Subtropical (rain) cloud forest
			f. Subtropical alluvial rain forest
			g. Subtropical swamp rain forest
			h. Subtropical evergreen bog forest (with organic surface deposits)
		5. Mangrove forest	

Appendix--Continued

CLASS	SUBCLASS	GROUP	FORMATION
I. Continued	A. Continued	6. Temperate and subpolar evergreen rain forest	a. Temperate evergreen seasonal lowland forest
			b. Temperate evergreen seasonal submontane forest
			c. Temperate evergreen seasonal montane forest
			d. Temperate evergreen dry "subalpine" forest
		7. Temperate evergreen seasonal broad-leaved forest	a. Temperate evergreen seasonal lowland forest
			b. Temperate evergreen seasonal submontane forest
			c. Temperate evergreen seasonal montane forest
			d. Temperate evergreen dry "subalpine" forest
		8. Winter-rain broad-leaved sclerophyllous	a. Winter-rain evergreen sclerophyllous lowland and submontane forest, over 50 m tall
			b. Winter-rain evergreen sclerophyllous lowland and submontane forest less than 50 m tall
			c. Alluvial and swamp forest
		9. Tropical and subtropical needle-leaved	a. Tropical and subtropical lowland and submontane evergreen needle-leaved forest
			b. Tropical and subtropical montane and subalpine evergreen needle-leaved forest
		10. Temperate and subpolar needle-leaved	a. Evergreen giant forest
			b. Evergreen forest with rounded crowns
			c. Evergreen needle-leaved forest with conical crowns
			d. Evergreen forest with cylindrical crowns (boreal)

Appendix--Continued

CLASS	SUBCLASS	GROUP	FORMATION
I. Continued	B. Mainly deciduous forest	1. Tropical and subtropical drought-deciduous	a. Drought-deciduous broad-leaved lowland and submontane forest
			b. Drought-deciduous montane (and cloud) forest
		2. Cold-deciduous, with evergreen trees	a. Cold-deciduous forest with evergreen broad-leaved trees and climbers
			b. Cold-deciduous broad-leaved forest with evergreen needle-leaved trees
		3. Cold-deciduous, without evergreen trees	a. Temperate lowland and submontane broad-leaved cold-deciduous forest
			b. Montane or boreal cold-deciduous forest
			c. Subalpine or subpolar cold-deciduous forest
			d. Cold-deciduous alluvial forest
			e. Cold-deciduous swamp or peat forest
	C. Extremely xeromorphic forest	1. Sclerophyllous	
		2. Thorn-forest	a. Mixed deciduous-evergreen thorn forest
			b. Purely deciduous thorn forest
		3. Mainly succulent	

Appendix--Continued

CLASS	SUBCLASS	GROUP	FORMATION
II. Woodland (open forest) (trees over 5 m tall forming 25% to 60% canopy coverage)	A. Mainly evergreen woodland	1. Broad-leaved	
		2. Needle-leaved	a. Evergreen needle-leaved woodland with rounded crowns
			b. Evergreen needle-leaved woodland with conical crowns
			c. Evergreen needle-leaved woodland with very narrow cylindro-conical crowns
	B. Mainly deciduous woodland	1. Tropical and subtropical drought-deciduous	a. Drought-deciduous broad-leaved lowland and submontane woodland
			b. Drought-deciduous montane (and cloud) woodland
		2. Cold-deciduous, with evergreen trees	a. Evergreen broad-leaved trees present
			b. Evergreen needle-leaved trees present
		3. Cold-deciduous, without evergreen trees	a. Broad-leaved deciduous woodland
			b. Needle-leaved deciduous woodland
			c. Mixed deciduous woodland broad-leaved and needle-leaved)
	C. Extremely xeromorphic woodland	1. Sclerophyllous	a. Evergreen sclerophyllous-dominated xeromorphic woodland
		2. Thorn-woodland	a. Mixed deciduous-evergreen thorn woodland
			b. Purely deciduous thorn woodland
		3. Mainly succulent	

Appendix--Continued

CLASS	SUBCLASS	GROUP	FORMATION
III. Shrubland (shrubs 0.5 to 5 m tall forming 26% or greater canopy coverage)	A. Mainly evergreen shrub-land	1. Broad-leaved	a. Low bamboo thicket b. Evergreen tuft-tree shrubland c. Evergreen broad-leaved hemisclerophyllous shrubland d. Evergreen broad-leaved sclerophyllous shrubland e. Evergreen suffruticose shrubland
		2. Needle-leaved and microphyllous	a. Evergreen needle-leaved shrubland b. Evergreen microphyllous shrubland
	B. Mainly deciduous shrubland	1. Drought-deciduous, with evergreen woody plants	
		2. Drought-deciduous, without evergreen woody plants	
		3. Cold-deciduous	a. Temperate deciduous shrubland b. Subalpine or subpolar deciduous shrubland c. Deciduous alluvial shrubland d. Deciduous peat shrubland
	C. Extremely xeromorphic (subdesert) shrubland	1. Mainly evergreen	a. Evergreen subdesert shrubland b. Semideciduous subdesert shrubland
		2. Deciduous	a. Deciduous subdesert shrubland without succulents b. Deciduous subdesert shrubland with succulents

Appendix--Continued

CLASS	SUBCLASS	GROUP	FORMATION
IV. Dwarf-shrubland (shrubs less than 0.5 m tall forming 26% or greater canopy coverage)	A. Mainly evergreen dwarf-shrubland	1. Closed	a. Evergreen caespitose closed dwarf-shrubland
			b. Evergreen creeping or matted dwarf-shrub thicket
		2. Open	a. Evergreen cushion shrubland
		3. Mixed with herbaceous	a. Truly evergreen dwarf-shrub and herb mixed formation
			b. Partially evergreen dwarf-shrub and mixed formation
	B. Mainly deciduous dwarf-shrubland	1. Facultative drought-deciduous	
		2. Obligatory drought-deciduous	a. Drought-deciduous caespitose dwarf-shrubland
			b. Drought-deciduous creeping or matted dwarf-shrubland
			c. Drought-deciduous cushion dwarf-shrubland
			d. Drought-deciduous mixed dwarf-shrubland
		3. Cold-deciduous	a. Cold-deciduous caespitose dwarf-shrubland
			b. Cold-deciduous creeping or matted dwarf-shrubland
			c. Cold-deciduous cushion dwarf-shrubland
			d. Cold-deciduous mixed dwarf-shrubland

Appendix--Continued

CLASS	SUBCLASS	GROUP	FORMATION
IV. Continued	C. Extremely xeromorphic (subdesert) shrubland	1. Mainly evergreen	a. Evergreen subdesert dwarf-shrubland
		2. Deciduous	a. Deciduous subdesert dwarf-shrubland without succulents
	D. Tundra	1. Mainly moss	a. Caespiteose dwarf-shrub--moss tundra b. Creeping or matted dwarf-shrub--moss tundra
		2. Mainly lichen	
	E. Mossy bog formations with dwarf-shrub	1. Raised bog	a. Typical raised bog (suboceanic, lowland and submontane) b. Montane (or "subalpine") raised bog c. Subcontinental woodland bog
		2. Nonraised bog	a. Blanket bog (oceanic lowland, submontane or montane) b. String bog

Appendix--Continued

CLASS	SUBCLASS	GROUP	FORMATION
V. Grassland/Herbaceous	A. Tall grassland	1. With a tree layer (11-25%)	a. Woody layer broad-leaved evergreen
			b. Woody layer broad-leaved semi-evergreen
			c. Woody layer broad-leaved deciduous
			d. Woody layer needle-leaved evergreen and broad-leaved deciduous
			e. Woody layer needle-leaved evergreen
		2. With a shrub layer (11-25%)	a. Shrub layer broad-leaved evergreen
			b. Shrub layer broad-leaved semi-evergreen
			c. Shrub layer broad-leaved deciduous
		3. With open layer of tuft plants, usually palms	a. Tall subtropical grassland with open groves of palms
		4. Without a woody layer	a. Tropical grassland
			b. Tall grassland consisting mainly of sod grasses
			c. Tall grassland consisting mainly of bunch

Appendix--Continued

CLASS	SUBCLASS	GROUP	FORMATION
V. Continued	B. Medium tall grassland	1. With a tree layer (11-25%)	a. Woody layer broad-leaved evergreen
			b. Woody layer broad-leaved semi-evergreen
			c. Woody layer broad-leaved deciduous
			d. Woody layer needle-leaved evergreen and broad-leaved deciduous
			e. Woody layer needle-leaved evergreen
			f. Woody layer needle-leaved evergreen and broad-leaved evergreen
		2. With a shrub layer (11-25%)	a. Shrub layer broad-leaved evergreen
			b. Shrub layer broad-leaved semi-evergreen
			c. Shrub layer broad-leaved deciduous
			d. Shrub layer of mainly deciduous thorny shrubs
			e. Shrub layer of mainly needle-leaved evergreen
		3. With an open layer of tuft plants, usually palms	a. Medium tall subtropical grassland with open groves of palms
		4. Without a woody layer	a. Medium tall grassland consisting mainly of sod grasses
			b. Medium tall grassland consisting mainly of bunch grasses

Appendix--Continued

CLASS	SUBCLASS	GROUP	FORMATION
V. Continued	C. Short grassland	1. With a tree layer (11-25%)	a. Woody layer broad-leaved evergreen
			b. Woody layer broad-leaved semi-evergreen
			c. Woody layer broad-leaved deciduous
		2. With a shrub layer (11-25%)	a. Shrub layer broad-leaved evergreen
			b. Shrub layer broad-leaved semi-evergreen
			c. Shrub layer broad-leaved deciduous
			d. Shrub layer of mainly deciduous thorny shrubs
		3. With an open layer of tuft plants, usually palms	
		4. With an open layer of tuft plants, usually dwarf-shrub	a. Tropical alpine open to closed bunchgrass communities with a woody layer of tuft plants
			b. Tropical or subtropical alpine bunchgrass vegetation with open layer of evergreen dwarf-shrubs
			c. Bunchgrass vegetation of varying coverage with dwarf-shrubs

Appendix--Continued

CLASS	SUBCLASS	GROUP	FORMATION
V. Continued	C. Continued	5. Without a woody layer	a. Short-grass communities composed of sod forming species
			b. Short-grass communities composed of bunchgrasses
		6. Mesophytic (alpine and subalpine meadows)	a. Sodgrass communities, usually dominated by hemicrytophytes
			b. Alpine and subalpine meadows of the higher latitudes
		7. Graminoid tundra	a. Graminoid sod-form tundra
	D. Forb-dominated vegetation	1. Tall	a. Mainly perennial flowering forbs, and ferns
			b. Fern thickets especially in humid climates
			c. Mainly annual forbs
		2. Low	a. Mainly perennial flowering forbs, and ferns
			b. Mainly annual forbs
	E. Hydromorphic fresh-water vegetation	1. Rooted	a. Tropical and subtropical forb formations without seasonal contrasts
			b. Middle and higher latitude forb formations with seasonal contrasts
		2. Free-floating	a. Tropical and subtropical free-floating formations
			b. Free-floating formations of the middle and higher latitudes

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